Solving Global Challenges Using Finance Science Past and Future

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China International Conference in Finance

July 11, 2018 Tianjin

Role of Financial Innovation and Finance Science in Economic Growth and Development

- Well-functioning financial system is essential for sustainable economic growth and development –financial innovation drives improvement of the financial system, and finance science, technology, and economic need drive financial innovation

  Robert M. Solow "Nobel Perspectives"
  ,https://www.ubs.com/microsites/nobel-perspectives/en/robert-solow.html
- Crisis can slow or even reverse financial innovation as in 2008-9. But crisis can also induce implementation of financial innovation which leads to a permanently improved financial system, as in the 1970s-1980s
- When did Finance become a science? 1950s-1960s
- When and why did finance science and finance practice become inexorably connected? 1970s-1980s

Finance Becomes a Science 1950s-1960s

- 1952 Diversification– Markowitz Mean-Variance Portfolio Theory
- 1953 Role of securities in optimal risk allocation- Arrow
- 1958 Hedging – Tobin risk-free asset in portfolio theory
- 1958 Corporate finance capital structure and payout policy – Miller and Modigliani
- 1960-3 First comprehensive individual stock return data base, Chicago Center for Research in Security Prices
- 1963-5 Efficient Market Hypothesis – Fama; Samuelson
- 1965 Risk-based differences in expected returns - Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM)
- 1965-70 Testing of various institutional investor performance using CAPM – Jensen, Roll

Major Financial and Economic Crisis 1970s: Risk Explosion and Stagflation in USA

- Multi-dimensional explosion of volatilities in the western economies reflected in financial systems
- Fall of Bretton Woods currency system
- First oil crisis in 1973-4 and a second one in 1979
- Double-digit inflation in the US highest since Civil War
- Double-digit interest rates , highest since Civil War
- No mortgage money: Regulation Q -5% deposit interest cap
- High unemployment ~9%:
- “Stagflation” unknown, and still unsolved, economic disease
- Stock market fell 50% in real terms mid 1973 – 1974
- 1973-1975 recession was really a 1970s recession because its effects extended into the 1980s

Risk Explosion 1970s Drives an Explosion of Financial Innovation in USA--Later Adopted Throughout the World--Finance Science and Practice Become Inexorably Linked

- Option exchange: financial value insurance
- Financial futures for currencies, interest rates, stocks
- NASDAQ , first electronic stock market
- Money market funds, high-yield and floating rate bonds
- Index funds Stage Coach Fund 1970 & Vanguard 1975
- TIAA-CREF institutional international diversification in stocks 1972
- ERISA 1974 employer-funded pension system creating pension funds
- May Day 1975 negotiated commissions- institutionalization of stock market
- Debt securitization and creation of a national mortgage market
- Eliminate destabilizing regulations: deposit rate ceilings
- Foundation set for globalization of capital markets: derivative markets adopted throughout the world and global diversification
- Finance science: existing and breakthrough quantitative models and data bases were essential for implementing these innovations

How Intangible Innovation from Wall Street Can Solve Very Tangible Challenges to Economic Growth, Stabilization and Funding Retirement on Main Street

- Eliminating the largest risk in banks (1980s)
  - How the largest risk in banks was eliminated forever without disturbing how they serve their customers or increasing the costs of the services
- Implementing more-efficient financial stabilization and growth policies (2018)
  - China Example: Capital controls, governance and local investment government stabilization policies and comparative-advantage strategy for growth, can each be executed without bearing the costly "side-effects" from inefficient diversification and improve stabilization
- Implementation of technology innovation in financial services,"FinTech" (2018)
  - Global Example: Financial and technological innovation, "FinTech", offers enormous opportunities for lower cost and better performing financial services globally, with disproportional improvements accruing to those who are currently underserved by current standards. Its implementation however faces challenges. FinTech success will disrupt current financial-service providers. Who will be the "winners" and "losers"?
- Addressing multiple policy objectives with a single financial innovation (2018)
  - Global Example: A bond design addresses retirement income solution, funding of infrastructure, and hedging tax revenues SeLFIES = standard-of-living indexed, forward-starting, income-only securities

How the Largest Risk in Banks was Eliminated Forever
Interest Rate Swap 1980s

Before Swap: Bank lends money to customers at a fixed interest rate and provides deposits and pays interest to customers at a floating rate

Bank Earnings = fixed-rate paid by borrowers – floating-rate paid to its depositors

Bank enters into an interest-rate swap contract where it

Pays: a fixed-rate rate of interest

Receives: a floating rate of interest

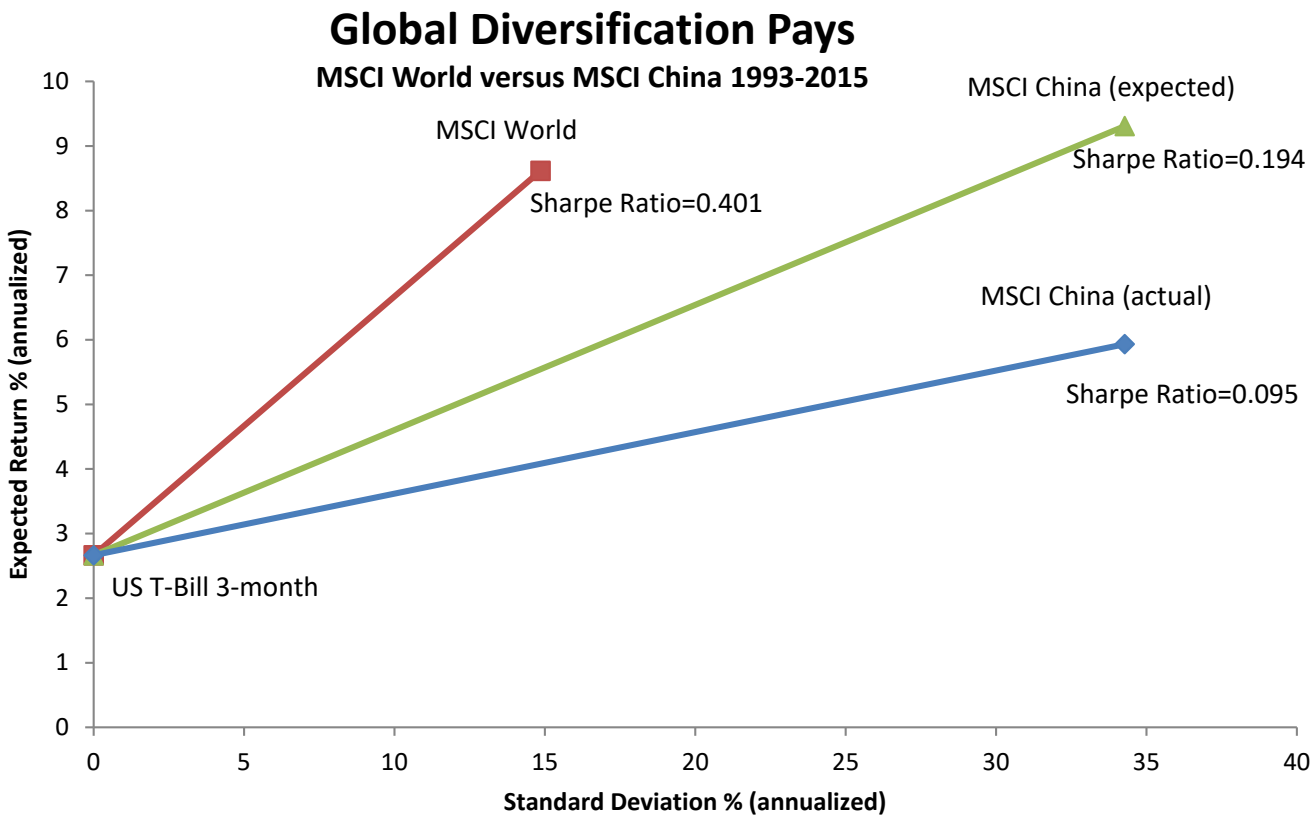
After: Still satisfies needs of both customers + swap contract which eliminates interest rate risk

Bank Earnings = [fixed-rate paid by borrowers – fixed-rate swap] + [floating-rate swap – floating-rate to depositors] = payment for banking services

Capital-Controls Stabilization,Governance and Local Investment Policies Have "Side-Effect" Cost of Inefficient Diversification

Cost of Restricting Investing and Risk-Bearing to Domestic Holders Can be Substantial – China as a Case Study

MSCI World versus MSCI China 1993-2015



Source: MSCI China total return index, MSCI World total return index, U.S. 3 month T-Bill rate, 1993-2015. Returns in USD. "Expected" = expost 0-alpha, conditional on World realized return

Financial Innovation Can Create Improved Policy-Objectives Implementation without the Unintended Cost of Inefficient Risk Diversification by Separating Risk Flows from Capital Flows, Investment and Governance

Before: SWF/ Pension Fund 100% invested in China A Share stocks

China SWF/Pension Fund Return = Return on Chinese A Share stocks
Concentrated Equity Risk

Enter into a Total-Return Swap contract where SWF/Pension Fund

Pays: Return on Chinese A Share stocks

Receives: Return on World stocks

After: Still 100% invested in China stocks as policy requires + swap contract which provides the efficient diversification

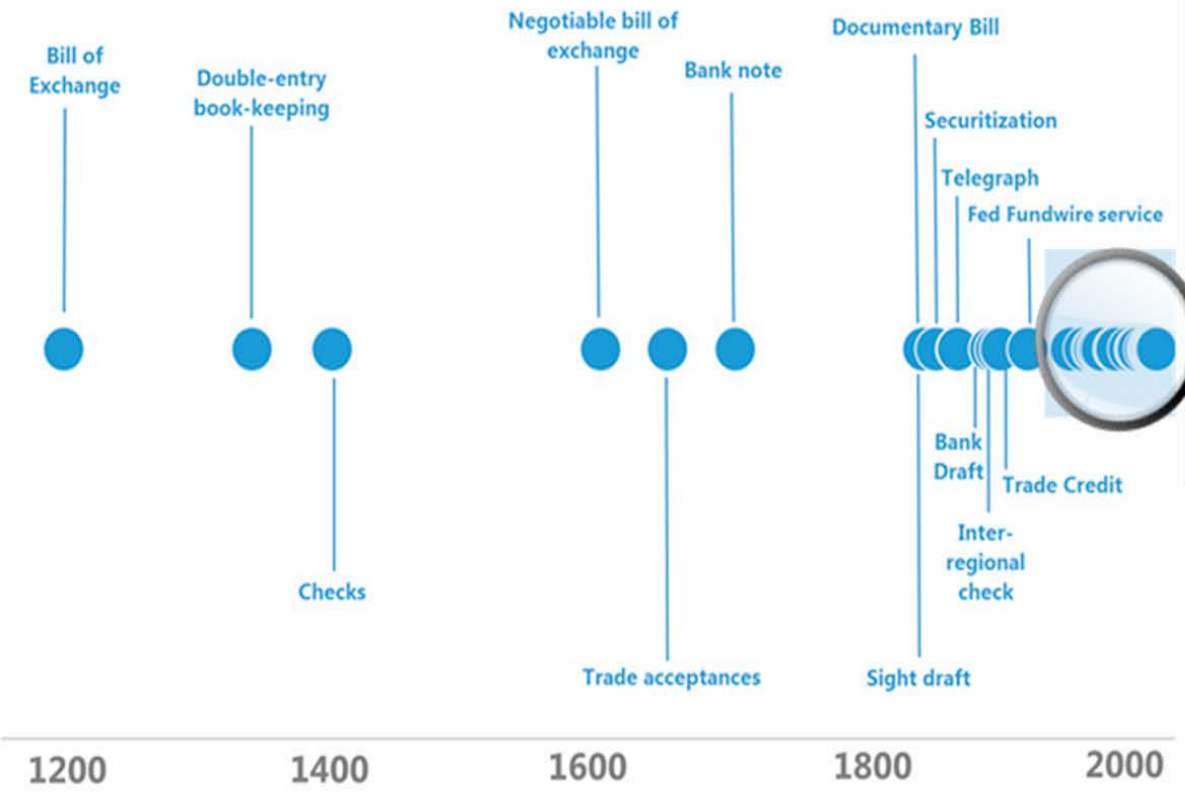
China SWF/Pension Fund Return = Return World stocks
Well-Diversified Equity Risk

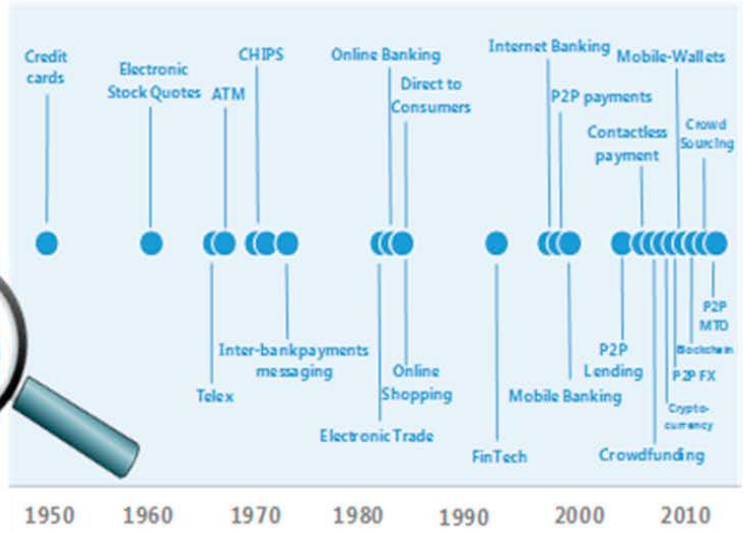
Note: China only has a cash outflow from the swap when China market outperforms the world markets which are "good times" for China and no need for capital-flight controls and actually receives cash inflow in "bad times". Non-Chinese counterparty gets efficient exposure to China A Shares from a credit-secure counterparty in size. May also help mitigate "asset bubble" risk in local market.

Country Swap Implementation for Efficient Risk Diversification

- ***Lower Cost of Capital and Higher Stock Prices*** through increased global risk-bearing of China risks
- ***Always Natural Counterparties Available***: if China has "too much" exposure to itself for efficient diversification, the rest of the world has "too little" exposure to China. Especially attractive for index institutional investors such core-equities in financial institutions and index mutual funds, that do not attempt market timing and are permanent, long-term investors.
- ***Credit Risk*****:** no principal amounts at risk; set frequency of payments (.25, 0.5, 1.0 years); "right-way" contract [pay when country is better able]; potential for credit guarantee and/or two-way-marked-to-market collateral, if deemed necessary
- ***Minimizes Moral Hazard Risks*** of expropriation, repudiation, taxes or accounting changes
- ***Execution and distribution:*** Foreign sovereign wealth funds, government pension funds, reserve funds, and central banks transact swaps directly with Chinese government institutions (SAFE, CIC, NCSSF), with no need to involve intermediary cost and credit risk. These Chinese institutions enter into similar swaps of global returns for China returns with local Chinese banks, insurance companies and asset management firms who then can distribute global diversification to Chinese retail investors.
- ***Reduce the distortions and risk of asset bubble formations in local assets*** by providing global investment exposure alternatives to local stocks, real estate and other assets
- ***Policy is non-invasive***: doesn't require change in employment patterns and behavior, changes in industrial structure or changes in financial system design or regulatory and stability policies
- ***Policy is reversible*** by simply entering into an off-setting swap
- ***Robust*** with respect to local financial system design

Accelerating Pace of Technological Progress in Financial Services





Sources: Arner, Barberis, and Buckley (forthcoming); Quinn and Roberds (2008); World Economic Forum (2015).

Implementation of Technology Innovation in Financial Services FinTech

- Financial and technological innovation, “FinTech”, offers enormous opportunities for lower cost and better performing financial services globally, with disproportional improvements accruing to those who are currently underserved by current standards.

- FinTech innovations will create disruptive challenges for users, providers, advisors and regulators of financial services but will also create potentially significant opportunities for them

- Will today’s technology disruptions to current practice of existing financial-service providers lead to their displacement or will it create enhanced opportunities for them? Who will be the “Winners” and “losers” ?

- Trust is essential for user adoption of financial services. Technology by itself is not sufficient to create trust.

Where in Finance Will FinTech Succeed Quickly and Where Will It Face Challenges? What Does It Take to Overcome the Challenges?

- FinTech will succeed most easily in areas of financial services involving calculations, processing and record-keeping where performance can be readily tested and verified, and in any activity in which transparency can be adequately substituted for opaqueness. Either transparency or verification, when feasible, can substitute for trust.
- FinTech requires a model and the data to populate it. The model selected will depend on the objectives of the selector. Models require abstractions from complex reality and the selection of the abstractions involves judgment—the “art of the science” . The quality of the data used in the model is critical. These judgments are opaque, often difficult to verify, and thus, inherently require trust by users.
- FinTech with technology alone will be challenged in disrupting services and products that are “inherently opaque [i.e., cannot be made transparent] such as financial advice, solutions and many integrated financial products. The only means of providing those services and products is through trust.

Verification: How Long Does It Take to Verify Superior Advice? How Much Outperformance or Underperformance is Required to Verify within a Fixed Time Horizon?

- Historical average return = 15% and standard deviation = 20%
- 95% confidence level of outperformance or underperformance [t-statistic = 2.0]
- What future realized sample returns would be needed to achieve significance?

PERIOD OF PAST HISTORY = 10 YEARS

Future Observation Period	Required Outcome
5 years	< - 12% or > 42%
10 years	< - 7% or > 37%
20 years	< - 5% or > 35%

PERIOD OF PAST HISTORY = 30 YEARS

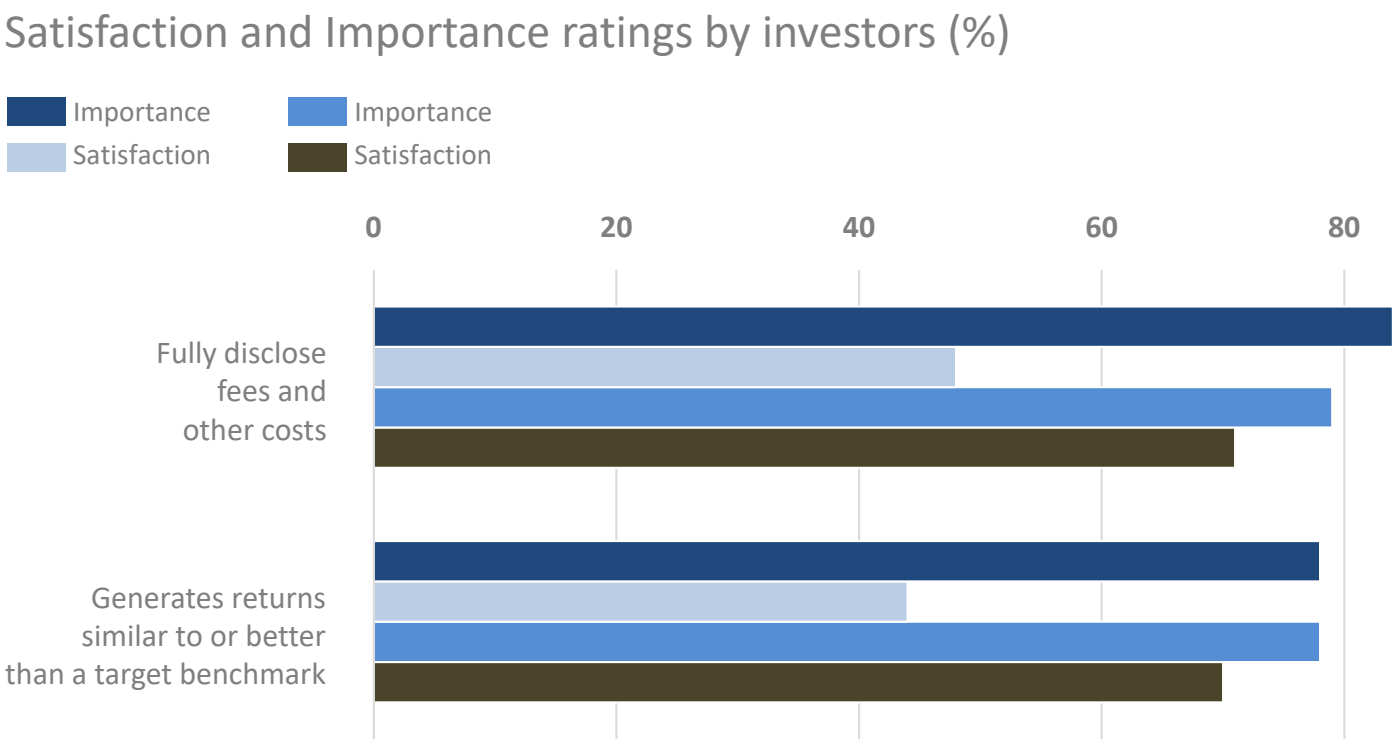
Future Observation Period	Required Outcome
5 years	< - 9% or > 39%
10 years	< - 3% or > 33%
20 years	< 0% or > 30%

Practical conclusion: performance cannot be verified based on return series alone

Trust is Essential for FinTech to Succeed and Fintech's Success Will Enhance the Value of Trust

- Trust requires two components: 1. trustworthy 2. competence.
- FinTech increases time efficiency and lowers cost by substituting "black box" technology for human efforts of both advisors and providers but in doing so it also increases "opacity", which in turn makes trust an even more important and valuable asset. FinTech's success will thus drive increasing value for the trusted advisor, provider, consultant and overseer.
- Technological advances will likely leverage providers who have the "trust asset" to enhance their expansion instead of taking business away from them. Technology to succeed will have to partner with entities that can provide the trust asset, since it cannot create trust by itself. The trusted provider must assess the risk of lost of its valuable asset by supporting a Fintech that fails. How will the value jointly created be shared between the technology and the trust assets?
- Consumers of financial services lost trust in their providers and their regulators in the 2008-9 crisis. Financial advisors and institutions with business strategies based on restoring trust by minimizing conflicts of interest, such as fee-only independent advisors, will disrupt traditional product-based wealth-management models with captive distribution broker and adviser systems. Will established institutions that are trusted and adopt Fintech have an advantage over new FinTech entrants into financial services? Will the industry become more fragmented or concentrated?

Missing Trust—Lost in Financial Crisis 2008-9
Retail Investors Register Low Satisfaction with Cost Disclosures and Performance from Active Portfolio Managers



Source: CFA Institute
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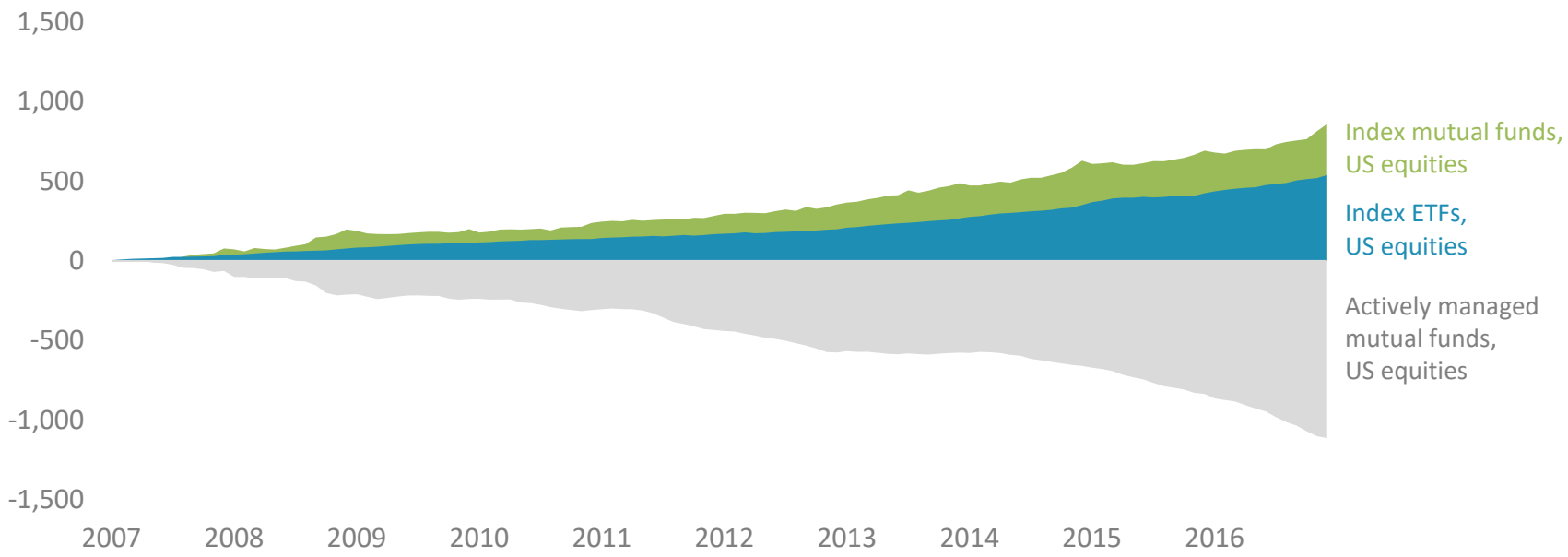
Growth of Index Funds and ETFs vs. Actively Managed Funds Industry Impact of a Loss of Investor Trust 2008-9 and a Continuing Flight to Transparency as a Second-Best Strategy?



Source: 2017 ICI Factbook. http://www.icifactbook.org/ch2/17_fb_ch2

Cumulative flows to and net share issuance of index mutual funds (US equities) and index ETFs (US equities), billions of dollars; monthly, January 2007–December 2016. Prior to October 2009, index equity Index ETF (US equities) data include a small number of actively managed domestic equity ETFs. Note: Equity mutual fund data include net new cash flow and reinvested dividends. Data exclude funds that invest primarily in other funds. The charts is for illustrative purposes only and are not indicative of any investment.

Block-Chain Technology with Great Potential Impact on Industry The Essential Role of Trust in Its Successful Implementation

- Determining ownership –clearing and settling transactions—is a fundamental function in both finance and real estate—Block Chain offers transformational potential for a non-centralized, efficient, low-cost and highly reliable method for clearing & settling.
- Block Chain cannot succeed unless it is accepted and therefore trusted.
- How do the users determine the motivation of the creator of the system?
- How do the users determine the quality of the specific block-chain model used in the system?
- How do the users determine the quality and completeness of the data used in the model?
- How do the users determine the degree of security for the data, the model and their personal information within the system?
- How do the users determine the reliability of who is responsible if the system fails?

Trust in Digital Currencies is Supported by Intrinsic Value
Fiat Currencies are Not All the Same: Legal Tender vs Not

- Legal-tender fiat currencies have intrinsic value because they can always be used to settle government obligations of taxes and fees ($4.8 trillion annually in US) and all legal-tender- denominated private-sector financial obligations.
- Fiat digital currencies that are not legal-tender do not have such intrinsic value.
- The viability of any currency depends on collective trust by its users and lack of any material intrinsic value is a prime sources of its instability.
- Because governments hold the ultimate responsibility for failures in their payment systems, it is difficult to imagine their accepting as legal tender any currency that was not under their control including controlling unobservable flows into and out of their jurisdictions by criminals and terrorists.
- Governments have the power to effectively ban the holding of any legal-tender currency surrogate [e.g., ban on US citizens ownership of gold prior to 1971]. Imposition of such a ban is a major risk for all non-legal-tender currencies and a source of instability.
- Prediction: only government-controlled digital currencies will be legal tender.

Bond Innovation for Retirement Income:SeLFIES = Standard-of-Living Indexed, Forward-starting, Income-only Securities

- **Forward-starting bond**:
  - Starts paying at a pre-determined future date (e.g., 2030, 2031…)
  - Periodic level-payouts for a fixed period (e.g., 20 or 25 years),with no principal or "balloon" payout at maturity…like an annuity with a pre-set period for payouts
  - Payouts are indexed to per-capita consumption: hedges both consumption inflation and standard-of-living risks
- **Safe, simple retirement funding solution with easy-to-understand benefit**

  Each bond pays $5 real per year for 20 years starting on a specified date

  ✓Participant selects and buys bond just using their retirement date and requires no other information and no need to take further future actions

  ✓Buying the bond today locks in retirement cash flows in the future

  ✓Payments are protected against *both* inflation and standard-of-living changes

  ✓Consumption CAPM predicts that an asset which is perfectly correlated with aggregate consumption would be a universally demanded asset for investors

Addressing Multiple Policy Objectives with a Single Bond Innovation: Retirement Income, Funding Infrastructure, and Hedging Tax Revenues by Issuing SelFIES

- **SeLFIES = Standard-of-Living Indexed, Forward-starting, Income-only Securities**
- **A bond innovation that addresses multiple policy objectives:**
- Retirement funding improvements for individuals and institutions; improve maturity-matching of funding for infrastructure investments to reduce re-financing risk and issuing costs; control government tax-revenue risk
- Addresses the challenge of a lack of financial literacy for retirement savers
- Pattern of delayed payouts for many years and then level payouts match infrastructure cash inflow pattern and provides a precise match to cash flow needs of retirees, so no further transactions needed by either issuer or buyer
- For governments with VAT, the bond payments are hedged by VAT revenues and hedges tax revenue risk
- A new-design bond issued by government to improve financial market "completion"

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Speaker Profile

Robert C. Merton is the School of Management Distinguished Professor of Finance at the MIT Sloan School of Management and John and Natty McArthur University Professor Emeritus at Harvard University. He was the George Fisher Baker Professor of Business Administration (1988–98) and the John and Natty McArthur University Professor (1998–2010) at Harvard Business School. After receiving a Ph.D. in Economics from MIT in 1970, Merton served on the finance faculty of MIT's Sloan School of Management until 1988 at which time he was J.C. Penney Professor of Management. He is currently Resident Scientist at Dimensional Fund Advisors, where he is the creator of Target Retirement Solution, a global integrated retirement-funding solution system

Merton received the Alfred Nobel Memorial Prize in Economic Sciences in 1997 for a new method to determine the value of derivatives. He is past president of the American Finance Association, a member of the National Academy of Sciences, and a Fellow of the American Academy of Arts and Sciences.

Merton has also been recognized for translating finance science into practice. He received the inaugural Financial Engineer of the Year Award from the International Association for Quantitative Finance (formerly International Association of Financial Engineers), which also elected him a Senior Fellow. He received the 2011 CME Group Melamed-Arditti Innovation Award, and the 2013 WFE Award for Excellence from World Federation of Exchanges. A Distinguished Fellow of the Institute for Quantitative Research in Finance ('Q Group') and a Fellow of the Financial Management Association, Merton received the Nicholas Molodovsky Award from the CFA Institute. He is a member of the Halls of Fame of the Fixed Income Analyst Society, Risk, and Derivative Strategy magazines. Merton received Risk’s Lifetime Achievement Award for contributions to the field of risk management and the 2014 Lifetime Achievement Award from the Financial Intermediation Research Society.

Merton’s research focuses on finance theory, including lifecycle and retirement finance, optimal portfolio selection, capital asset pricing, pricing of derivative securities, credit risk, loan guarantees, financial innovation, the dynamics of institutional change, and improving the methods of measuring and managing macro-financial risk. Merton received a B.S. in Engineering Mathematics from Columbia University, a M.S. in Applied Mathematics from California Institute of Technology and a Ph.D. in Economics from Massachusetts Institute of Technology and holds honorary degrees from eighteen universities. http://robertcmerton.com/